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## Compressed Gas Cylinder Safety

Hazards associated with compressed gases can include oxygen displacement, fires, explosions, and toxic gas exposures, as well as the physical hazards associated with high pressure systems. Special storage, use, and handling precautions are necessary in order to control these hazards.

### Definition of a Compressed Gas

A compressed gas is any material or mixture in the container with:

1. Absolute pressure exceeding 40 pounds per square inch (psi) at 70°F
2. Absolute pressure exceeding 104 psi at 130°F
3. Any liquid flammable material having a vapor pressure exceeding 40 psi absolute at 100°F

### General Safety Procedures

#### **Using Compressed Gas Cylinders**

1. Know the contents of gas cylinders and be familiar with the specific properties of the gas before using it.
2. Never use a cylinder containing a gas that cannot be positively identified; cylinder color coding is an unreliable identifier of cylinder contents because varies among gas vendors.
3. Handle all compressed gas cylinders as a high energy source (potentially explosive).
4. Most gas cylinders are equipped with pressure safety devices. Know the type and location of the pressure relief devices on any cylinder brought into a lab. There are three general types of devices that are used separately or in combination on cylinders including:
  - a. Rupture disks
  - b. Pop valves
  - c. Fusible metal plugs - Fusible metal plugs are designed to melt between 158°F and 194°F
5. The maximum discharge pressure of cylinder regulators should not exceed the pressure rating of the plumbing or equipment downstream of the regulator.
6. Before disassembling plumbing or equipment downstream of a regulator, be sure that the gauge pressure is at zero.
7. Use cylinders with matched Compressed Gas Association (CGA) connectors and the proper regulator. Gas cylinder regulators are designed such that they will only fit specific cylinder gas types.
  - a. Left handed threads are often found on cylinders containing combustible gases.
  - b. Do not install cylinder adapters on a regulator
  - c. Do not use Teflon tape on compression fittings

- d. Routinely inspect regulators as described in the ***Regulator Inspection Recommendations*** section below.
8. Oxygen cylinders require special, dedicated regulators.
  - a. Oil present in other gases can contaminate regulators causing a serious explosion hazard if a used regulator is reused on an oxygen cylinder.
9. Close the pressure-reducing valve before gas is allowed to enter the regulator.
10. Test cylinder connections by spraying connections with a soapy solution and looking for bubbles.
11. Ensure the cylinder valve is closed before removing a regulator from a cylinder.
12. Use only metallic tubing when connecting flammable gas to equipment.
13. Open cylinder valves slowly.
14. Never crack the valve on an unregulated cylinder.
15. Never open the main cylinder valve all the way. Open only to the extent necessary.
16. Never tamper valve parts such as the safety or packing nuts.
17. Do not empty cylinders to a pressure lower than (20 psig); leave cylinders slightly pressurized to keep contaminants out.
18. Empty cylinders should not be refilled by anyone except the gas supplier.
19. When a cylinder is empty, remove the regulator, replace the valve cap and mark the cylinder as “Empty”.
20. Equip cylinder discharge lines with approved check valves to prevent inadvertent contamination of cylinders where the possibility of flow reversal exists.
21. Label and return cylinders suspected to be contaminated to the supplier.
22. When toxic gases with no physiologic warning (hydrogen sulfide, CO, etc.) are being used a “watcher” procedure should be used:
  - a. A second individual trained in the emergency shutdown procedure is present in the laboratory as a watcher.
  - b. The watcher may perform other work in the laboratory but should not leave the lab for any reason while the toxic gas is in use.
23. A Flow Restrictor Cylinder Valve (FRV) is recommended when using flammable or toxic gases.
  - a. The FRV orifice considerably reduces the full-open leak rate in event of a major leak (e.g., regulator diaphragm failure).

### **Storage and Handling of Compressed Gases**

1. Conspicuously label cylinders and cylinder storage areas with the names of gases being stored.
2. Securely anchor gas cylinders at all times. Secured cylinders to a heavy bench or wall using a cylinder clamp or chain.
3. Do not store or leave cylinders unattended in hallways, corridors, stairways, or other areas of egress.
4. Store gas cylinders in ventilated areas away from heat or ignition sources where temperatures could exceed 120 °F.
5. Separate oxidizing gas and flammable gas cylinders by at least 20 feet.
6. Do not store more than three (3) cylinders of flammable and/or oxygen gases in a lab at a time.
7. Keep hydrogen gas cylinders at least 20 feet from flammable materials or oxidizers.
8. Keep hydrogen gas cylinders at least 25 feet from open flames or sources of ignition,
9. Keep hydrogen gas cylinders at least 50 feet from other cylinders containing flammable gas, air intakes, or air compressors.
10. Label hydrogen cylinder storage areas with a placard that states “HYDROGEN-FLAMMABLE GAS-NO SMOKING / NO OPEN FLAMES”.

11. Ground all cylinders containing flammable gases.
12. Store acutely toxic gasses (NFPA Health Rating of 3 or 4) gases and gases with a NFPA Health Rating of 2 that have no physiological warning properties in an enclosure that has continuous mechanical ventilation.
13. Vent pressure-relief devices on cylinders of flammable, toxic, or corrosive gasses to a working exhaust duct or fume hood.
14. Use regulators with vented bonnets on cylinders containing toxic or corrosive gases.
15. Depressurize regulators on cylinders when not in use.
16. Remove the regulator and cap the cylinder valve if a cylinder is not going to be used for a long time.
17. Do not leave partly assembled apparatus attached to gas cylinders in storage.
18. Locate cylinders so that valves are accessible at all times.
19. Close the main valve on gas cylinders when not in use.
20. Cap main valves whenever moving or storing gas cylinders.
21. Use a wheeled cylinder cart to move large gas cylinders.
22. Do not transport gas cylinders in an occupied elevator. If a cylinder must be moved by elevator, secure the tank in the elevator and send it to the destination floor by itself. Have someone ready to unload the cylinder from the elevator as soon as it reaches the destination floor.
  - a. Elevators are confined spaces and a sudden release of gas in a closed elevator poses a serious asphyxiation risk to anyone in the elevator.

### **Regulator Inspection Recommendations**

1. A routine preventative maintenance program is highly recommended for all gas regulators.
  - a. Corrosive gas regulators should be overhauled semi-annually (every 6 months).
  - b. Toxic gas regulators should be overhauled annually.
  - c. Service any regulator that shows gauge pressure discrepancies, bubbles during a leak testing or other abnormal characteristics.
  - d. Keep regulator inspection records for new and rebuilt units to ensure inspections are performed at required intervals.

### **Recommended Regulator Maintenance Schedule**

<b>SERVICE</b>	<b>LEAK CHECK</b>	<b>CREEP TEST</b>	<b>INERT PURGE</b>	<b>OVERHAUL</b>	<b>REPLACE</b>
<b>Noncorrosive</b>	Monthly	annually	Not Applicable	5 years	10 years
<b>Mildly corrosive</b>	2x Month	6 months	at shutdown	2 years	4 years
<b>Corrosive</b>	2x Month	3 months	at shutdown	1-2 years	3-4 years

Source: Scott Specialty Gas

### **Cylinder (Pressure Vessel) Inspection Requirements**

1. Compressed gas cylinders must hydrostatically tested by manufacturers / distributors every 5 or 10 years. This date is stamped into the neck of the cylinder. A star stamped next to the date indicates a 10 year certification. No star indicates a five year certification. If a gas cylinder is out of date it is recommended the cylinder be exchanged regardless of how full the gas cylinder is.

## High Pressure Reactors and Toxic Gas Handling Systems

Prior approval by NMSU EH&S and, if applicable, department safety committee, is required before apparatus construction begins on high pressure reactors and toxic gas handling systems. Submit a completed Experiment Safety Plan (ESP) for the design prior to beginning work. Include a description of failure mode effects for all system components.

### High Pressure Reactor Barricades & “Watcher” Requirements

1. Operators of reactors located in barricades or cubicles can only enter a reactor cubicle or open a barricade during a reaction run when:
  - a. A second individual trained in the emergency shutdown procedure is present in the laboratory as a watcher.
  - b. The operator informs the watcher when they are entering or exiting from the reactor cubicle or opening the barricade.
  - c. The watcher may perform other work in the laboratory but may not leave the lab for any reason while the equipment operator is in the barricade or cubicle.

#### REFERENCE:

Compressed Gas Association, Inc., Pamphlet P-1994.